STEAM AND HYDRAULIC MACHINERY.

DAVEY'S PATENT DIFFERENTIAL PUMPING ENGINE.

DAVEY'S DIFFERENTIAL HYDRAULIC ENGINE.

HYDRAULIC RAMS FOR RAISING WATER.

HYDRAULIC HOISTS. HYDRAULIC ORGAN-BLOWERS.

The Differential Steam-Pump.

ROTATIVE STEAM-PUMPS, FOR BOILER FEEDING AND GENERAL PURPOSES.

COMPOUND ROTATIVE STEAM-ENGINES.

THE SEPARATE CONDENSER.

DIFFERENTIAL CORNISH PUMPING ENGINES.

DIFFERENTIAL BLOWING ENGINES.

HAULING ENGINES WORKED BY STEAM, WATER, OR COMPRESSED AIR.

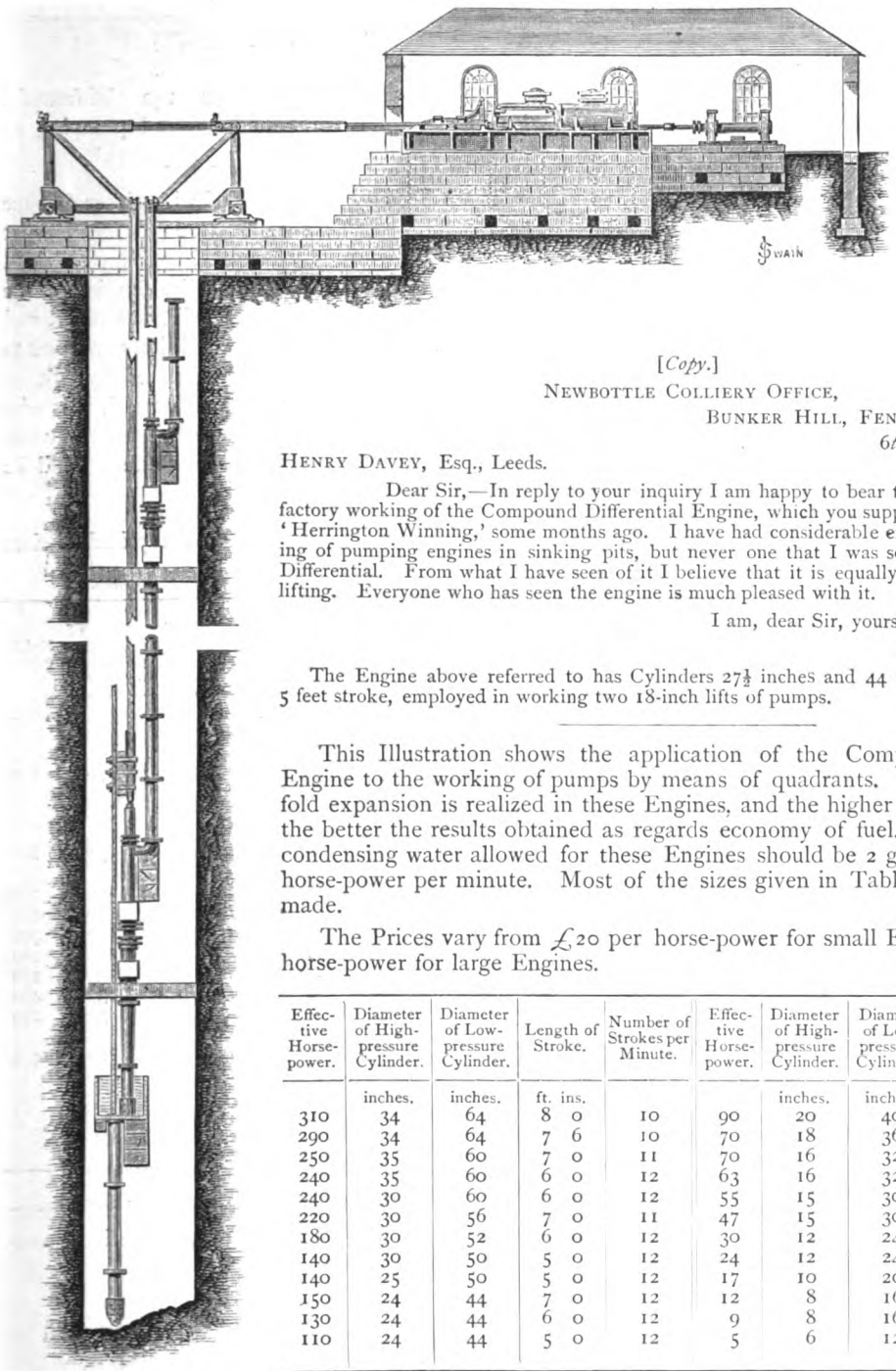
All kinds of Pumping and Winding Machinery, &c., &c., &c.

CATALOGUES ON APPLICATION.

FOR PARTICULARS SEE FOLLOWING PAGES.

HATHORN DAVIS, CAMPBELL, AND DAVEY,
ENGINEERS, SUN FOUNDRY, LEEDS, ENGLAND.
LONDON OFFICE:
4, WESTMINSTER CHAMBERS,
WESTMINSTER, S.W.

COMPOUND DIFFERENTIAL ENGINE.



[*Copy.*]

NEWBOTTLE COLLIERY OFFICE,
BUNKER HILL, FENCE HOUSES,
6th January, 1875.

HENRY DAVEY, Esq., Leeds.

Dear Sir,—In reply to your inquiry I am happy to bear testimony to the satisfactory working of the Compound Differential Engine, which you supplied to Earl Durham's 'Herrington Winning,' some months ago. I have had considerable experience in the working of pumping engines in sinking pits, but never one that I was so satisfied with as the Differential. From what I have seen of it I believe that it is equally suitable for forcing or lifting. Everyone who has seen the engine is much pleased with it.

I am, dear Sir, yours truly,

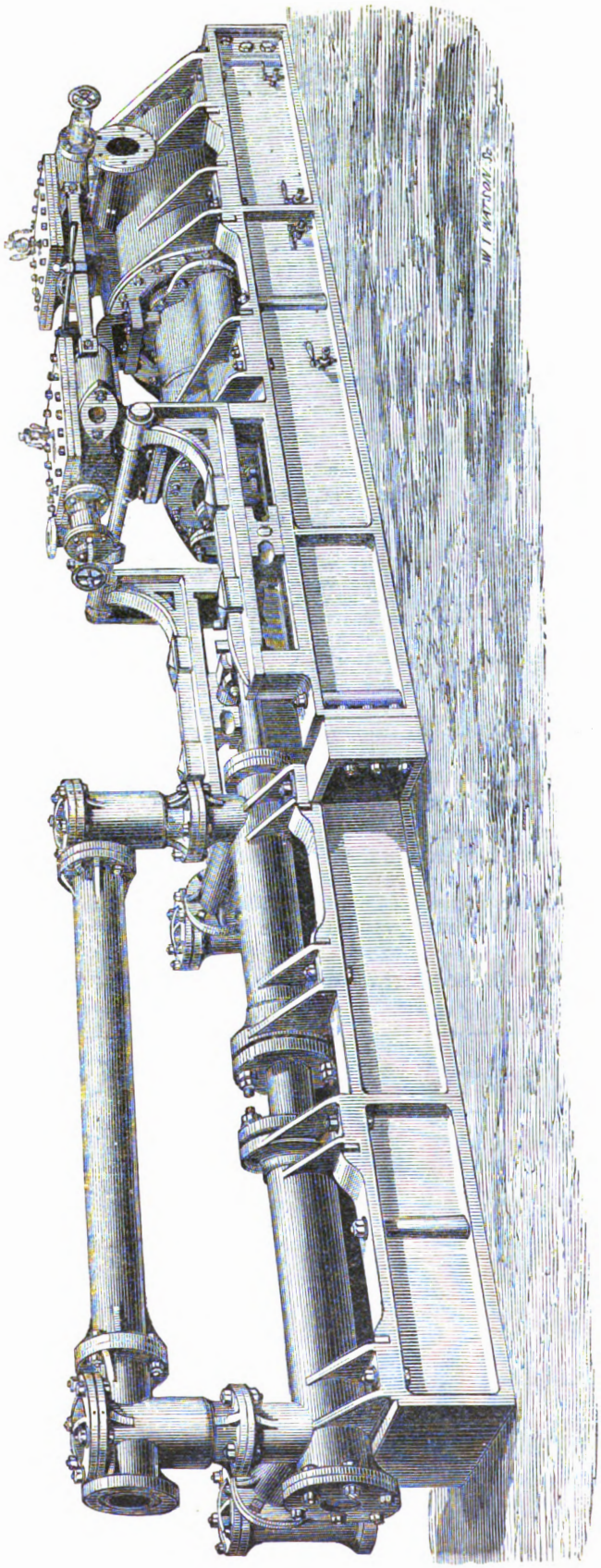
W. LISHMAN.

The Engine above referred to has Cylinders 27½ inches and 44 inches in diameter by 5 feet stroke, employed in working two 18-inch lifts of pumps.

This Illustration shows the application of the Compound Differential Engine to the working of pumps by means of quadrants. From four to ten fold expansion is realized in these Engines, and the higher the boiler pressure the better the results obtained as regards economy of fuel. The quantity of condensing water allowed for these Engines should be 2 gallons per effective horse-power per minute. Most of the sizes given in Table below have been made.

The Prices vary from £20 per horse-power for small Engines to £10 per horse-power for large Engines.

Effective Horse-power.	Diameter of High-pressure Cylinder.	Diameter of Low-pressure Cylinder.	Length of Stroke.	Number of Strokes per Minute.	Effective Horse-power.	Diameter of High-pressure Cylinder.	Diameter of Low-pressure Cylinder.	Length of Stroke.	Number of Strokes per Minute.
	inches.	inches.	ft. ins.			inches.	inches.	ft. ins.	
310	34	64	8 0	10	90	20	40	5 0	12
290	34	64	7 6	10	70	18	36	5 0	12
250	35	60	7 0	11	70	16	32	6 0	12
240	35	60	6 0	12	63	16	32	5 0	13
240	30	60	6 0	12	55	15	30	5 0	13
220	30	56	7 0	11	47	15	30	4 0	14
180	30	52	6 0	12	30	12	24	4 0	14
140	30	50	5 0	12	24	12	24	3 0	15
140	25	50	5 0	12	17	10	20	3 0	15
150	24	44	7 0	12	12	8	16	3 0	15
130	24	44	6 0	12	9	8	16	2 6	15
110	24	44	5 0	12	5	6	12	2 6	15



COMPOUND DIFFERENTIAL PUMPING ENGINE AND PUMPS.

(DAVEY'S PATENT.)

The Illustration represents the Differential Engine as applied for underground pumping as described in outline of "Davey's System."

These Engines are provided with either Surface or Injection Condensers, and are so designed that Pumps of any size can be fixed to them provided the strokes are the same as the Engine. The Pumps are of the Double-acting Ram variety, and though much more costly, are infinitely superior to the Piston Pumps, not being affected by grit or sand in the water. For permanent work it is wise to have gun-metal Rams. Two gallons of water per effective horse-power per minute should be allowed for condensing.

The following Table contains the principal sizes made:

Effective Horse-power.	Diam. of High-pressure Cylin.	Diam. of Low-pressure Cylin.	Length of Stroke.	No. of Strokes per Minute.	Diam. of Pump Ram.	No. of Gallons raised per min.	Height of Lift.
	inches.	inches.	ft. in.		inches.		feet.
290	34	64	7 6	10			
250	35	60	7 0	11			
240	35	60	6 0	12	12½	700	910
240	30	60	6 0	12			
220	30	56	7 0	11			
180	30	52	6 0	12			
140	30	50	5 0	12	12	500	800
140	25	50	5 0	12			
130	24	44	6 0	12	11½	560	700
110	24	44	5 0	12	11½	500	600
90	20	40	5 0	12	9	300	700
70	18	36	5 0	12	17	1000	180
63	16	32	5 0	12	17	1000	150
55	15	30	5 0	12	9	300	400
47	15	30	4 0	14	12½	520	240
30	12	24	4 0	14			
24	12	24	3 0	15	6	100	400
17	10	20	3 0	15			
12	8	16	3 0	15			
9	8	16	2 6	15			
5	6	12	2 6	15			

Prices vary from £12 per effective horse-power for the large Engines to £25 per effective horse-power for small ones.

HATHORN DAVIS, CAMPBELL, AND DAVEY,

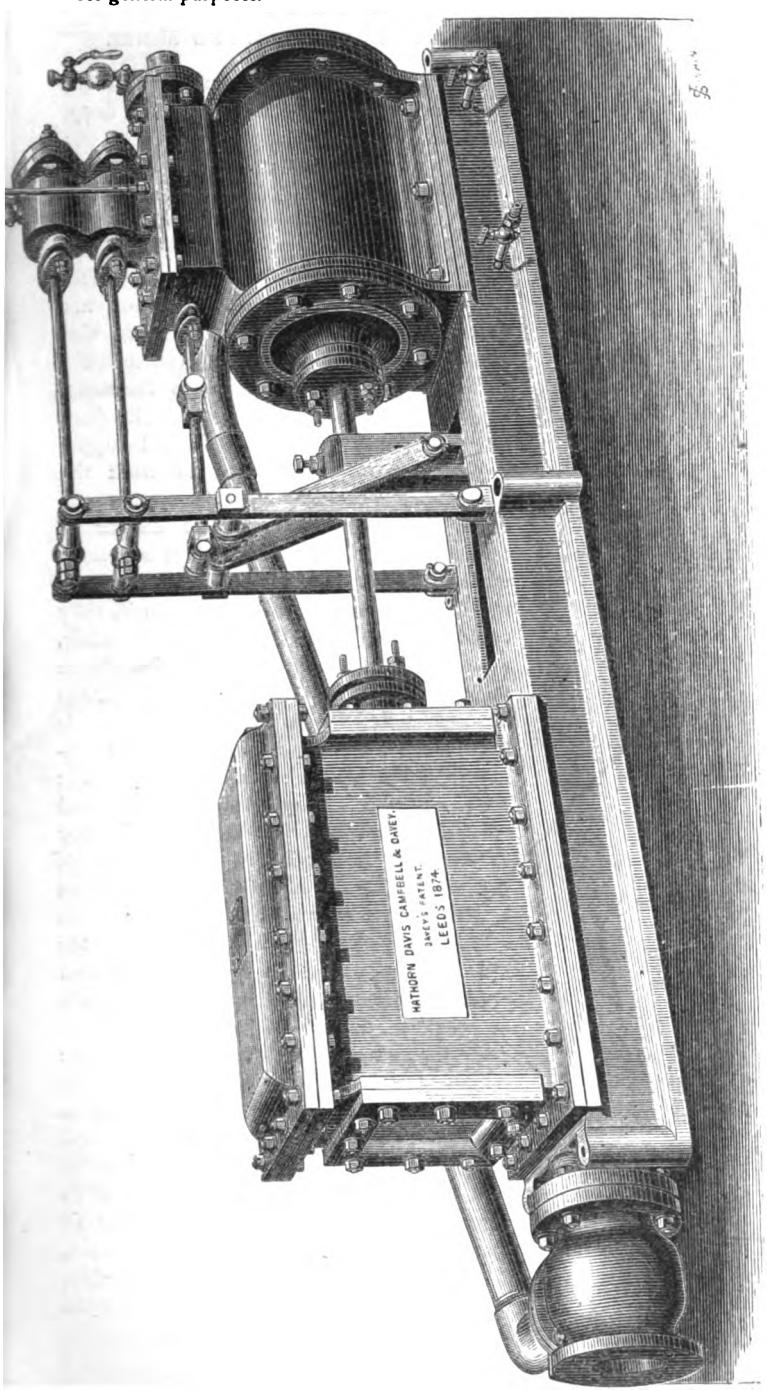
ENGINEERS,

SUN FOUNDRY, LEEDS, ENGLAND.

LONDON OFFICE: 4, WESTMINSTER CHAMBERS, WESTMINSTER, S.W.

THE DIFFERENTIAL STEAM-PUMP.

The Engraving represents a Differential Steam-Pump fitted with a Condensing apparatus, by means of which the exhaust steam is condensed and economy of fuel effected. In ordering these Pumps it should be stated whether the Condenser is required or not. The following Table gives full particulars of the different Sizes and Prices, exclusive of the Condenser, for which add 10% to the price. The Sizes marked with the asterisk are not designed for boiler feeding, but for general purposes.

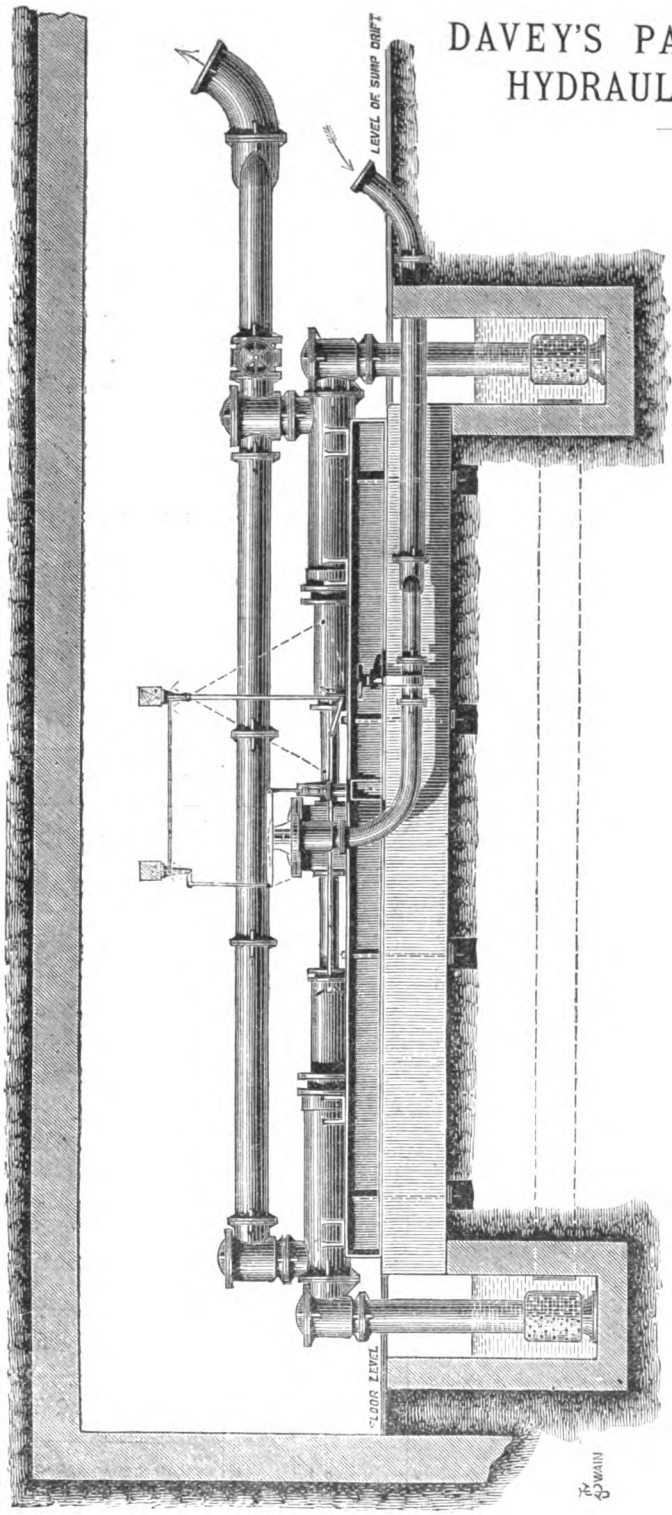


Diam. of Steam Cyl.	Diam. of Pump.	Length of Stroke.	Number of Strokes per minute.	Number of Gallons per hour.	Horse-power of Boiler supplied allowing 2 cubic feet per H.P. per hour.	Diam. of Steam Pipe.	Diam. of Exhaust Pipe.	Diam. of Suction and Delivery Pipes.	Height to which Water may be forced with 50 lb. Boiler-press.	Price.
ins.	ins.	inches.				inches.	inches.	inches.	feet.	£
4	2	5½	100	710	56	¾	1	1¼	200	32
6	3	8	70	1694	135	1	1¼	3	200	48
6	4	8	70	2710	216	1	1¼	3	100	53
5	5	8	60	3870	*	1	1¼	4	60	62
7	5	8	60	3870	309	1	1¼	4	100	64
7	5	10	60	4980	398	1	1¼	4	100	75
6	6	10	60	7200	*	1	1¼	4	60	77
8	6	10	50	5810	464	1¼	2	4	100	81
9	5	10	50	4120	330	1¼	2	4	150	86
4	2	5½	50	355	28	¾	1	1¼	200	30
6	3	8	35	847	68	1	1¼	3	200	44
6	4	8	35	1355	108	1	1¼	3	100	49
5	5	8	30	1935	*	1	1¼	4	60	58
7	5	8	30	1935	154	1	1¼	4	100	60
7	5	10	30	2490	199	1	1¼	4	100	71
6	6	10	30	3600	*	1	1¼	4	60	73
8	6	10	25	2905	232	1¼	2	4	100	77
9	5	10	25	2060	165	1¼	2	4	150	82
4	2	5½	200	1420	112	¾	1	1¼	200	34
6	3	8	140	3388	271	1	1¼	3	200	52
6	4	8	140	5420	433	1	1¼	3	100	57
5	5	8	120	7740	*	1	1¼	4	60	66
7	5	8	120	7740	619	1	1¼	4	100	68
7	5	10	120	9960	797	1	1¼	4	100	79
6	6	10	120	14400	*	1	1¼	4	60	81
8	6	10	100	11620	929	1¼	2	4	100	85
9	5	10	100	8240	659	1¼	2	4	150	90
4	2	5½	300	2130	170	¾	1	1¼	200	38
6	3	8	210	5082	406	1	1¼	3	200	56
6	4	8	210	8130	650	1	1¼	3	100	61
5	5	8	180	11610	*	1	1¼	4	60	70
7	5	8	180	11610	929	1	1¼	4	100	72
7	5	10	180	14940	1195	1	1¼	4	100	83
6	6	10	180	21600	*	1	1¼	4	60	85
8	6	10	150	17430	1394	1¼	2	4	100	89
9	5	10	150	12360	989	1¼	2	4	150	94
4	2	5½	400	2840	227	¾	1	1¼	200	42
6	3	8	280	6776	542	1	1¼	3	200	60
6	4	8	280	10840	867	1	1¼	3	100	65
5	5	8	240	15480	*	1	1¼	4	60	74
7	5	8	240	15480	1238	1	1¼	4	100	76
7	5	10	240	19920	1594	1	1¼	4	100	87
6	6	10	240	28800	*	1	1¼	4	60	89
8	6	10	200	23240	1859	1¼	2	4	100	93
9	5	10	200	16480	1318	1¼	2	4	150	98
4	2	5½	500	3550	284	¾	1	1¼	200	46
6	3	8	350	8470	677	1	1¼	3	200	64
6	4	8	350	13550	1084	1	1¼	3	100	69
5	5	8	300	19350	*	1	1¼	4	60	78
7	5	8	300	19350	1548	1	1¼	4	100	80
7	5	10	300	24900	1992	1	1¼	4	100	91
6	6	10	300	36000	*	1	1¼	4	60	93
8	6	10	250	29050	2324	1¼	2	4	100	97
9	5	10	250	20600	1648	1¼	2	4	150	102
4	2	5½	600	4260	341	¾	1	1¼	200	50
6	3	8	420	10164	813	1	1¼	3	200	68
6	4	8	420	16260	1301	1	1¼	3	100	73
5	5	8	360	23220	*	1	1¼	4	60	82
7	5	8	360	23220	1858	1	1¼	4	100	84
7	5	10	360	29880	2390	1	1¼	4	100	95
6	6	10	360	43200	*	1	1¼	4	60	97
8	6	10	300	34860	2789	1¼	2	4	100	101
9	5	10	300	24720	1978	1¼	2	4	150	107
4	2	5½	700	4970	398	¾	1	1¼	200	54
6	3	8	490	11858	949	1	1¼	3	200	72
6	4	8	490	18970	1518	1	1¼	3	100	77
5	5	8	420	27090	*	1	1¼	4	60	86
7	5	8	420	27090	2167	1	1¼	4	100	88
7	5	10	420	34860	2789	1	1¼	4	100	99
6	6	10	420	50400	*	1	1¼	4	60	101
8	6	10	350	40670	3254	1¼	2	4	100	105
9	5	10	350	28840	2307	1¼	2	4	150	112
4	2	5½	800	5680	454	¾	1	1¼	200	58
6	3	8	560	13552	1084	1	1¼	3	200	76
6	4	8	560	21680	1734	1	1¼	3	100	81
5	5	8	480	30960	*	1	1¼	4	60	90
7	5	8	480	30960	2476	1	1¼	4	100	92
7	5	10	480	39840	3187	1	1¼	4	100	103
6	6	10	480	57600	*	1	1¼	4	60	105
8	6	10	400	46480	3718	1¼	2	4	100	109
9	5	10	400	32960	2636	1¼	2	4	150	116
4	2	5½	900	6390	511	¾	1	1¼	200	62
6	3	8	630	15246	1219	1	1¼	3	200	80
6	4	8	630	24390	1951	1	1¼	3	100	85
5	5	8	540	34830	*	1	1¼	4	60	94
7	5	8	540	34830	2786	1	1¼	4	100	96
7	5	10	540	44820	3585	1	1¼	4	100	107
6	6	10	540	64800	*	1	1¼	4	60	109
8	6	10	450	52290	4183	1¼	2	4	100	113
9	5	10	450	37080	2966	1¼	2	4	150	120
4	2	5½	1000	7100	568	¾	1	1¼	200	66
6	3	8	700	16940	1355	1	1¼	3	200	84
6	4	8	700	27100	2168	1	1¼	3	100	89
5	5	8	600	38700	*	1	1¼	4	60	98
7	5	8	600	38700	3096	1	1¼	4	100	100
7	5	10	600	49800	3984	1	1¼	4	100	111
6	6	10	600	72000	*	1	1¼	4	60	113
8	6	10	500	58100	4648	1¼	2	4	100	117
9	5	10	500	41200	3296	1¼	2	4	150	124

Several Sizes always on Stock or in progress.

HATHORN DAVIS, CAMPBELL, AND DAVEY,

ENGINEERS, SUN FOUNDRY, LEEDS, ENGLAND. LONDON OFFICE: 4, WESTMINSTER CHAMBERS, WESTMINSTER, S.W.



DAVEY'S PATENT DIFFERENTIAL HYDRAULIC PUMPING ENGINE.

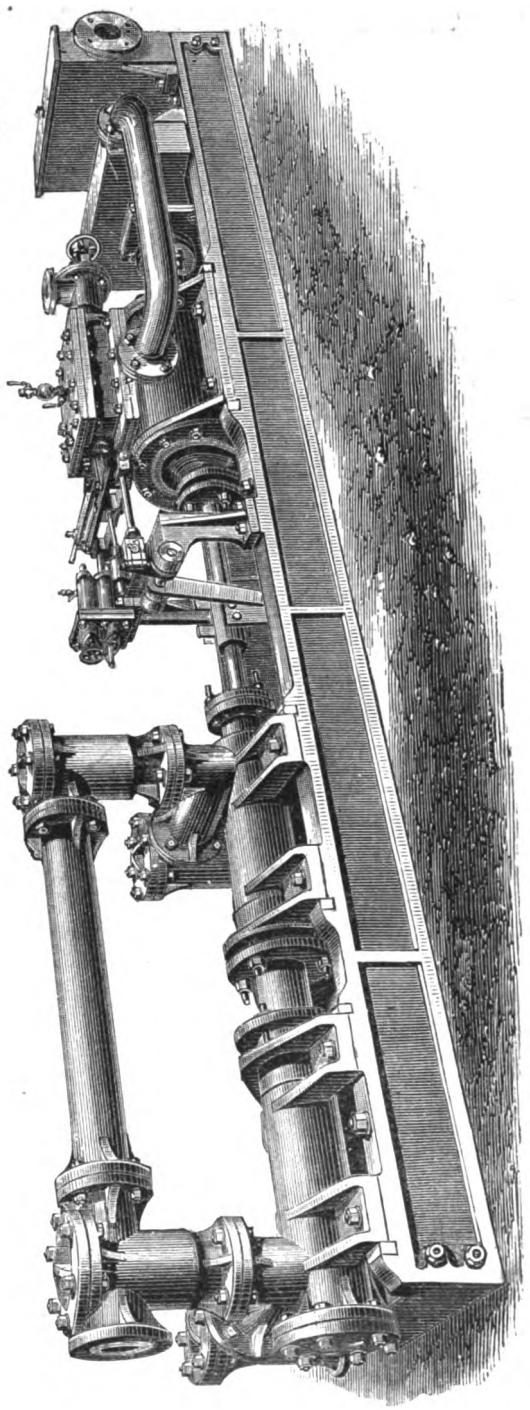
DAVEY'S SYSTEM OF UNDERGROUND PUMPING FOR COLLIERIES AND MINES.

This system, which is being carried out on a large scale in a colliery 1200 feet deep, may be thus described. At a point 900 feet from the surface are placed a pair of Compound Differential Engines and Pumps (with separate Condenser, similar to that illustrated in the page immediately following). At the bottom of the pit, 300 feet below the Differential Steam Engines, are placed a pair of Hydraulic Pumping Engines (as here illustrated), and these lift a thousand gallons per minute to the main Engines. The main (Differential) Engines force the water to the surface and supply power through the column to work the Hydraulic Engines. By this system the main Engines are kept out of danger of flooding. The Hydraulic Engines will work under water and can be actuated from the main Engine Room. As further security they could be placed in a water-tight chamber, accessible from the main Engine Room through a water-tight staple. By such means the Hydraulic Engines could be under repair even when the water rose to the main Engines, 300 feet up the shaft. The Hydraulic Engine has a variety of applications, and may be worked from a natural head of water or from an Accumulator, the principle of its action being the employment of water at a given head to raise a larger quantity against a less head. In hilly mining districts water may be accumulated at a high elevation and conducted to the mine in pipes, where it could be employed in actuating one of these Engines for pumping the water from the mine; in this way the cost of Steam power may often be saved. The Hydraulic Engine is also suitable for accumulating power and transmitting it from one point to another far distant. For example, water flowing from an elevation on one side of a valley may be made to pump water to a higher elevation, either on the same or on the opposite side, where it may be stored for use or employed in giving motion to machinery, &c.

HATHORN DAVIS, CAMPBELL, AND DAVEY,
ENGINEERS, SUN FOUNDRY, LEEDS, ENGLAND. LONDON OFFICE: 4, WESTMINSTER CHAMBERS, WESTMINSTER, S.W.

THE SINGLE-CYLINDER DIFFERENTIAL PUMPING ENGINE AND DOUBLE-RAM PUMPS.

(DAVEY'S PATENT.)



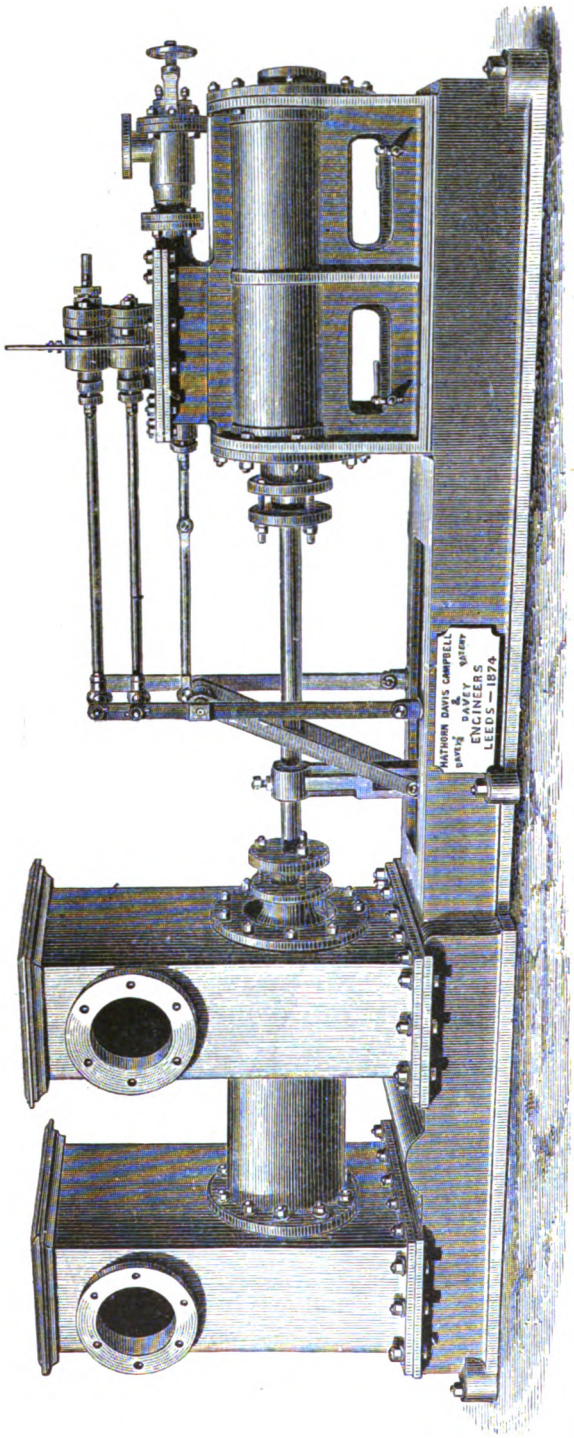
These Engines are made either Condensing or Non-condensing. Pumps of any size can be put to any of the Engines mentioned in the following Table. The quantity of condensing water required varies with the power developed, but may be approximately calculated at about 3 gallons per actual horse-power per minute.

Dia. of Cyl.	Length of Stroke.	Number of Strokes per Minute.	Diameter of Pump.	Number of Gallons per Minute.	Height of Lift.
	ft. ins.		inches.		feet.
12	1 8	20	6		
12	1 8	20	6	90	250
12	3 0	15	8		
14	2 0	20	6		
14	2 0	20	8		
14	3 0	15	9		
16	2 0	20	8½		
16	3 0	15	10		
18	2 0	20	11	200	135
18	3 0	15	10	290	
18	4 0	13			
20	2 0	20			
20	3 0	15	4½	58	1000
20	4 0	13			
22	2 0	20	8	160	400
22	3 0	15			
22	4 0	13			
26	3 0	15	12½	450	240
26	4 0	13			
28	4 0	13			
28	5 0	12			
30	3 0	15	9	230	480
30	4 0	13			
35	5 0	12			
40	5 0	12			
52	5 0	12	9½ & 11½	300 & 500	700 & 500

HATHORN DAVIS, CAMPBELL, AND DAVEY,
ENGINEERS, SUN FOUNDRY, LEEDS, ENGLAND. LONDON OFFICE: 4, WESTMINSTER CHAMBERS, WESTMINSTER, S.W.

THE SEPARATE CONDENSER.

(DAVEY'S PATENT.)



This Condenser has been designed to meet the want felt at the present time for a Condenser capable of being easily applied to existing non-condensing engines, to economize fuel and to increase the power. By its application from 30 to 40 per cent. increased power is available, and from 30 to 40 per cent. of fuel is saved.

The Air Pump of the Separate Condenser is worked by means of a small Differential Steam-Engine. In applying the Condenser to an existing engine all that is necessary is to fix it in any convenient place and lead the exhaust and a small steam pipe to it.

For Winding Engines the Separate Condenser is invaluable, because the vacuum is not at all impaired by the repeated stopping of the engine. When this Condenser is applied to engines situated underground in mines, a hydraulic engine is sometimes used to work the Air Pump, the power being obtained from the column or the tubbing.

The advantages claimed for this Condenser are:

1st.—*Economy of Fuel and Increase of Power.* The additional average pressure available on the piston of the engine by the use of the Separate Condenser may be taken as 12 lb. per square inch, consequently, if the engine is not required to do additional work the average steam pressure may be reduced 12 lbs. This, in cases where the average steam pressure is not high, would represent a saving of 40 per cent. of steam, and in the majority of cases the saving would much exceed 30 per cent.

2nd.—The vacuum is maintained unimpaired when the engine is irregular in its working and when it ceases to work, which makes it peculiarly advantageous for winding engines.

3rd.—One Condenser may be made to condense the steam for several independent engines.

4th.—The Condenser being entirely distinct from the engine, it is more accessible, is easier managed, and in the case of requiring repairs it does not prevent the engine being worked as a non-condensing engine.

5th.—A Boiler-feed Pump may be combined with the Separate Condenser, arranged to feed the boilers from the hot well.

In writing for estimates the following particulars of the engine or engines to which the Condenser is to be applied should be stated, viz.:

Number of Cylinders .. ..
Diameter of Cylinders .. ..
Length of Stroke .. ..
Greatest number of Strokes per minute ..
Average pressure of Steam during the Stroke
Type of Condenser, *Surface or Injection* ..
Is the Condenser required to increase the power of the Engine or to economize fuel?

HATHORN DAVIS, CAMPBELL, AND DAVEY,
ENGINEERS, SUN FOUNDRY, LEEDS, ENGLAND. LONDON OFFICE: 4, WESTMINSTER CHAMBERS, WESTMINSTER, S.W.